The effects of depth separation on lightness contrast and lightness assimilation

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In lightness contrast, a grey target neighbouring white appears darker than a grey target neighbouring black, whereas in assimilation, a grey target neighbouring white appears lighter than a grey target neighbouring black. As shown in figure 1, spatial frequency (i.e. size and number) of inducers can determine whether contrast (top row) or assimilation (bottom row) occurs.

The interaction of the spatial frequency and colour of inducers with depth is less clear. With low-spatial-frequency inducers, Wolff (1933) reported that contrast disappears when the target is moved into a different depth plane to the inducers; whereas Julesz (1971) and Gibbs and Lawson (1974) reported that contrast continues to occur in depth conditions. With high-spatial-frequency inducers, although assimilation occurs when the target and inducers are coplanar, contrast occurs when the inducers are non-coplanar with the targets (e.g. Soranzo, Galmonte & Agostini, 2010).

One difference between these studies is that Wolff (1933) manipulated actual depth, whilst Julesz (1971), Gibbs and Lawson (1974), and Soranzo et al. (2010) manipulated stereoscopic depth.

To investigate the effects of depth separation on contrast and assimilation, the current study manipulated three variables:

• Actual distance between target and inducers (coplanar vs non-coplanar)
• Spatial frequency of inducers (high vs low)
• Colour of inducers (black vs white)

RESULTS
Responses were converted as follows: \( \log \left( \frac{\text{lum (Match)}}{\text{lum (Target)}} \right) \) and an average of the two matches per condition was computed for each participant. See figure 4 below for the mean match in each condition across all participants.

• There was a significant three-way interaction between spatial frequency, colour, and distance (\( F(1,19)=39.15, p<.001, \eta_p^2=.67 \)).
• The two-way interaction between spatial frequency and colour was significant in the coplanar conditions (\( F(1,19)=97.10, p<.001, \eta_p^2=.84 \)) but non-significant in the distance conditions (\( F(1,19)=172, p=.68, \eta_p^2=.01 \)).

METHOD
Participants - 20 volunteers with normal (or corrected-to-normal) vision and no prior knowledge of the experiment.

Design and Stimuli - Eight conditions (2x2x2 within-participants design)

Stimuli:
• A ‘grey target’ (31.9 cd/m²)
• Inducers were either printed onto a grey target (coplanar condition); or cut from white or black paper and suspended from a frame placed 28cm in front of the target (distance condition)
• Inducers were either white (54.2 cd/m²) or black (3.4 cd/m²)
• Displays were viewed through a viewing window (10.3cm x 10.3cm)
• Equivalent visible surface area of the grey target across conditions.
• Low-spatial-frequency conditions: visible grey area (8cm x 8cm) surrounded by an inducer extending from the edge of the grey area.
• High-spatial-frequency inducers consisted of 88 small rectangles (1.2cm x 0.3cm) distributed across 15 thin lines.

Procedure
In a matching task, participants were required to indicate the patch on the matching chart that was printed with the same grey that the target was cut from.

• Between trials, participants turned away to allow the researcher to change the display and matching chart, according to a randomised list.
• Participants each responded to two repetitions of each stimulus, each presented alongside different versions of the matching chart.

REFERENCES